TIME DOMAIN REFLECTOMETRY (TDR) SYSTEM MANUAL

QUICK-START

DOCUMENTATION for TACQ.EXE

by

CABLING

Steven R. Evett
USDA-ARS, P.O. Drawer 10
2300 Experiment Station Road
Bushland, TX 79012
srevett@bushlandars.com

INSTALLING TDR PROBES and CABLES

TR-200 MULTIPLEXER

This manual was prepared by a USDA employee as part of his official duties and cannot legally be copyrighted. The fact that the private publication in which the chapter may appear is itself copyrighted does not affect the material of the U.S. Government, which can be reproduced by the public at will.

The mention of trade or manufacturer names is made for information only and does not imply an endorsement, recommendation, or exclusion by USDA-Agricultural Research Service

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, and marital or familial status (Not all prohibited bases apply to all programs). Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact the USDA's TARGET Center at 202-720-2600 (Voice and TDD). To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washingtion, DC 20250, or call 1-800-245-6340 (voice) or 202-720-1127 (TDD). USDA is an equal opportunity employer.

SOLAR POWER and POWER CONTROL

PRINCIPLES and METHODS for TIME DOMAIN REFLECTOMETRY

TEKTRONIX 1502 MODIFICATION for WAVEFORM OUTPUT

TIME DOMAIN REFLECTOMETRY (TDR) SYSTEM MANUAL

by

Steven R. Evett
USDA-ARS, P.O. Drawer 10
2300 Experiment Station Road
Bushland, TX 79012
srevett@bushlandars.com

This manual was prepared by a USDA employee as part of his official duties and cannot legally be copyrighted. The fact that the private publication in which the chapter may appear is itself copyrighted does not affect the material of the U.S. Government, which can be reproduced by the public at will.

The mention of trade or manufacturer names is made for information only and does not imply an endorsement, recommendation, or exclusion by USDA-Agricultural Research Service

The United States Department of Agriculture (USDA) prohibits discrimination in its programs on the basis of race, color, national origin, sex, religion, age, disability, political beliefs, and marital or familial status (Not all prohibited bases apply to all programs). Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact the USDA's TARGET Center at 202-720-2600 (Voice and TDD). To file a complaint, write the Secretary of Agriculture, U.S. Department of Agriculture, Washingtion, DC 20250, or call 1-800-245-6340 (voice) or 202-720-1127 (TDD). USDA is an equal opportunity employer.

TABLE OF CONTENTS

1	QUICK-START	1-1
	1.1 Time Domain Reflectometry (TDR) Systems	1-3
	1.2 Tektronix 1502B or 1502C cable testers, Reading Single Probes	1-3
	1.2.1 Set Up the Probe in Software Setup	
	1.2.2 Position the Wave Form on the Screen and Save Position	1-6
	1.2.3 Connect a Probe and Make a Reading	. 1-10
	1.3 Dynamax Modified Tektronix 1502 Cable Tester	. 1-11
	1.4 Systems with One Multiplexer	. 1-13
	1.4.1 Connect Multiplexer	. 1-13
	1.4.2 Set Up Parallel Port	. 1-13
	1.4.3 Test Multiplexer and Connect Probes	. 1-14
	1.4.4 Set Up Multiplexer and Probe Connections in Software	. 1-14
	1.4.5 Set Up Individual Probe Distances and Wave Form Positions	
	1.5 Systems with Several Multiplexers	
	1.6 Manual and Automatic Readings	. 1-23
2	DOCUMENTATION FOR TACQ.EXE	2-1
	2.1 Program Capabilities	
	2.2 Hardware and Operating System Requirements	
	2.3 Running TACQ Automatically	
	2.4 Main Menu	2-4
	2.4.1 Software Setup	2-4
	2.4.1.1 Press T to choose a TDR instrument	2-5
	2.4.1.2 Press 1 to choose global defaults	2-5
	2.4.1.3 Press S to change serial port settings	2-6
	2.4.1.4 Press P to change parallel port settings &	
	cable tester power control	
	2.4.1.5 Press O to set up other data acquisition	2-7
	2.4.1.6 Press F to set files for automatic data acquisition	2-8
	2.4.1.7 Press W to set the write path	
	2.4.1.8 Press A to set the automatic data acquisition interval	
	2.4.1.9 Press D to set date and time	
	2.4.1.10 Press M to set multiplexer and probe connections	2-9
	2.4.1.11 Press L to set cable lengths to probes,	
	and individual probe Vp and DIST/DIV settings	
	2.4.1.12 Press I to change graphical interpretation methods	
	2.4.2 Bring in a Wave Form	
	2.4.3 File Functions	
	2.4.3.1 Press A for automatic data acquisition mode	
	2.4.3.2 Press S to acquire single wave forms	
	2.4.3.3 Press T to enter test mode	
	2.4.3.4 Press R to read in previously acquired wave forms	. 2-12

2.4.4 Graph TDR Data	2-13
2.4.5 Control Multiplexers	
2.4.6 Toggle Modified 1502 Cable Tester	
2.5 Set Multiplexer and Probe Connections	
2.6 Setting Cable Lengths, Vp and DIST/DIV	
2.7 Algorithms for Reducing Wave Forms to Water Contents	
2.8 File Formats	
2.8.1 Automatically Collected Files	
2.8.2 Manually Collected Files	
·	
3 CABLING	
TR-1058 Coaxial Extension Cable	3-1
TR-2000 Modem Type Serial Cable	
TR-2001 Extended Length Serial Cable	3-4
TR-2002 Serial Cable to Dynamax modified Tektronix 1502	3-4
TR-2200 Power and Multiplexer Control Cable	3-6
TR-2200 A	3-7
TR-2200 B	3-7
TR-2200 C	3-7
TR-2201 Cable Tester Power/Control Extension	3-7
TR-250 Multiplexer Power/Control Extension	3-8
4 INSTALLING TDR PROBES and CABLES	4-1
5 TR-200 MULTIPLEXER	5-1
6 COLAD DOWED and DOWED CONTROL	6.1
6 SOLAR POWER and POWER CONTROL	
6.1 Power Requirements	
6.1.1 Multiplexer Power Requirements	
6.1.2 Computer and Cable Tester Power Requirements	
6.2 Length of Data Acquisition Period	
6.3 Power Available from the Sun	
6.4 Power Available from a Solar Panel	
6.5 Sizing a Solar Power System	
6.7 Cable Tester Power Control with the TR-304 AC Power Control Module	
6.8 Connect External 12 VDC Power to the 1502C TDR Cable Tester	
6.9 Control 12 VDC Power to the 1502C TDR Cable Tester	6-10
7 PRINCIPLES and METHODS for TIME DOMAIN REFLECTOMETRY	7-1
7.1 Introduction	
7.2 The TDR Method for Water Content Determination	
7.3 Description of Wave Form Features as Related to the TDR Probe -Theor	
7.4 Visual Wave Form Interpretation and Early Computer Programs	•
7.5 Factors Influencing Wave Form Shape	
7.5.1 Dry Soil	
7.5.2 Probe Design	
···· =	

7.5.3 Bulk Electrical Conductivity	7-9
7.5.4 Equipment and Acquisition Method	7-10
7.5.5 Cable Length	7-11
7.6 Algorithms for Graphical Interpretation of Wave Forms	7-12
7.6.1 Positioning of the Wave Form on the Screen	7-12
7.6.2 Wave Form Smoothing	7-15
7.6.3 Circumscribing Wave Form Interpretation	7-15
7.6.4 Choosing Wave Form Interpretation Methods	7-15
7.6.5 Finding Travel Times	7-16
7.7 References	7-18
Appendix 7-A, Computer code for best combination of Vp and Dist/Div	7-19
8 TEKTRONIX 1502 MODIFICATION for WAVEFORM OUTPUT 8.1 Modifying the Tektronix 1502 for Digital Toggling of Waveform Output	8-1 8-2 8-3 8-6 8-6 8-6 8-7 8-7
8.2.2.3 Testing	8-10